The Life and Work of Jacob Hermann
A Working Conference
Part 2 (Ravello, September 28–29, 1990), and Part 3 (Pisa, February 25–26, 1991)

By Fritz Nagel

Bernoulli-Edition, % Universitätsbibliothek, Schönbeinstrasse 18, CH-4056 Basel, Switzerland

Two sequels of the working conference on Jacob Hermann (1678–1733) announced in Historia Mathematica **18,** 64–65, took place in Ravello and Pisa (Italy). They were again organized by Sandra Giuntini (Dipartimento di Matematica, Florence).

At Ravello (Villa Rufolo) the following papers were presented and discussed:

Antonio C. Garibaldi (Genoa): La *Phoronomia* di Hermann, prima parte: I Principi della Meccanica
Livia Giacardi (Turin): Il *De calculo integrali* di Hermann
Elisabetta Ulivi (Florence): La geometria nell'opera di Hermann
Silvia Roero (Turin): I rapporti di Hermann con gli Italiani durante il periodo padovano
Silvia Mazzone (Rome): Il carteggio fra Hermann e Grandi

At Pisa (Dipartimento di Matematica dell'Università) the series of lectures was continued by the following papers:

Lucia Grugnetti (Cagliari): Hermann e le forze centrali, parte I [Hermann in discussion with Johann Bernoulli]
Sandra Giuntini (Florence): Hermann e le forze centrali, parte II [Hermann in discussion with Giuseppe Verzaglia]
Aldo Brigaglia (Palermo): Il calcolo nella *Phoronomia* di Hermann

There will be another sequel soon.

Hegel and Newtonianism

By M. J. Petry

Faculteit der Wijsbegeerte, Erasmus Universiteit Rotterdam, 3000 DR Rotterdam, The Netherlands

A conference on *Hegel and Newtonianism*, sponsored by the Istituto Italiano per gli Studi Filosofici, Naples, was held at Trinity College, Cambridge, August 30—September 4, 1989. Its main purpose was to bring together Newton scholars and others working on the history of eighteenth century mathematics and natural science, and those Hegel scholars who have been calling attention to the significance of his work on the foundations of mathematics and the general principles of the natural sciences.

Four of the five sections were devoted to those branches of natural science in which Hegel attempted to bring about a reassessment of the Newtonian legacy. In respect to each of the individual issues, a lecture on the eighteenth century Newtonian approach was followed by another on the Hegelian response. In *Mechanics* there were papers on the circularity involved in defining mass in terms of density, the problem of fall, and experiments with the pendulum; in *Astronomy*, on universal gravitation, forces and occult qualities, and the process of deduction by means of which the laws of motion and universal gravitation may be made to yield Kepler's three laws of planetary motion; in *Optics*, on the nature of light, the reasons for rejecting the modification theory of colour, and the physical and physiological factors involved in coloured shadows; in *Chemistry*, on atomism in the explanation of the chemical process, the problem of chemical affinity, and chemistry and the organic sciences. In so far as these sections were concerned with mathematical issues, it was, therefore, with those of *applied* mathematics.

One important general conclusion with respect to the relationship between pure and applied mathematics was that Newton and Hegel were in substantial agreement on the necessity of an exact definition of the systematic context of mathematical reasoning. Newton was well aware of the differences between the geometrical demonstrations of the *Principia* and those of the *Opticks*, and he realized that his mathematics threw no light at all upon his chemical researches.

The most controversial issue raised regarding this relationship between pure and applied mathematics concerned Newton's treatment of centripetal forces and the motion of bodies in eccentric conic sections in the first book (Sections II and III) of the *Principia*. Hegel pointed out, as early as 1801, that Proposition I, Theorem I cannot be regarded as an adequate geometrical presentation of Kepler's second law, since "it shows that the arcs as well as the areas are proportional to the times, whereas what should have been shown is that the areas alone are proportional to the times, and certainly not the arcs." In his subsequent lectures he pointed out that in Section III Newton's mathematical reasoning is not concerned with Kepler's first law, that is to say the specific curve of the ellipse, but simply with the conic section in general: "the conditions which make the path of the body a *specific* conic section are constants; and their determination is made to depend upon an *empirical* circumstance, i.e. a particular position of the body at a certain point of time, and the fortuitous strength of the original *impulse* it is supposed to have received. In this way the circumstance which determines the curved line into an ellipse falls outside the formula which is supposed to be proved, and the attempt to prove it is never made." His main point was, therefore, that in these sections of the *Principia* Newton was giving a mathematical description of empirical data, not providing a mathematical justification of Kepler's laws. There would appear to be good reasons for thinking that Newton would probably have agreed. In his preface to the first edition of the *Principia* he had noted that "geometry is founded in mechanical practice, and is nothing but that part of universal mechanics which accurately proposes and demonstrates the art of measuring." Most of the propositions of Book I, Section 3 are presented in the conditional mode, "if a body revolves in an ellipse . . . ," "suppose a body to move in an hyperbola . . . ," "if a body moves in the perimeter . . . ," etc.

Nevertheless, Robert Weinstock (Department of Physics, Oberlin College, Oberlin, Ohio) created quite a stir among the Newton scholars present with his paper "A Worm in Newton's Apple," in which he submitted Section III to close analysis and drew the conclusion that it contains no logically or mathematically valid proof that for non-straight-line motion, an inverse-square central force implies a conic-section orbit with one focus at the center of force. Bruce Brackenridge (Lawrence University, Appleton, Wisconsin), in "The Primary Challenge of Newton's *Principia*: Universal Gravitation from Elliptical Orbits," took up this issue, which he saw as a questioning of one of Newton's most important accomplishments, and emphasized the mathematical validity of the manner in which Newton solved the "direct" problem of deriving the inverse-square law from the elliptical orbit. Since Weinstock had been concerned with the "inverse" problem of deriving the elliptical orbit from the inverse-square law, some of the subsequent discussion was at cross-purposes, but it was interesting to see how the issues at stake converged upon the basic Hegelian analysis of this aspect of Newton's applied mathematics.

The more purely mathematical treatment of centripetal forces and eccentric conic sections in the first book of the *Principia* was meant to lay the foundation for the treatment of the concrete and specific phenomena of the solar system in Book III. For Newton, therefore, mathematics was an abstraction from nature which is applied to data or concrete phenomena in order to make them more intelligible: "In mathematics we are to investigate the quantities of forces with their proportions consequent upon any conditions supposed; then, when we enter upon physics, we compare those proportions with the phenomena of Nature, that we may know what conditions of those forces answer to the several kinds of attractive bodies. And this preparation being made, we argue more safely concerning the physical species, causes and proportions of the forces." (*Principia*, Bk. I, Sect. XI, Scholium).

Hegel appreciated the merits of this Newtonian conception of mathematics and singled out the abstract or purely universal aspect of his conception of evanescent divisible quantities (*Principia*, Bk. I, Lemma XI, Scholium) for particular praise: "The thought cannot be more correctly determined than in the way Newton has stated it. . . He explains that he understands by these fluxions not *indivisibles* (a form which was used by earlier mathematicians, Cavalieri and others, and which involves the concept of an intrinsical determinate quantum), but *vanishing divisibles*; also not sums and ratios of determinate parts but the *limits* of *sums* and *ratios*. It may be objected that vanishing magnitudes do not have a *final ratio*, because the ratio before it vanishes is not final, and when it has vanished it is no longer a ratio. But by the ratio of vanishing magnitudes is to be understood not the ratio *before which* and *after which* they vanish, but *with which* they vanish. Similarly, the *first* ratio of nascent magnitudes is that *with which* they become." (*Science of Logic* p. 255.) Hegel distinguished very sharply, however, between this abstract or purely universal aspect of the matter, which had to be dealt with as essentially a *logical* issue, and "those determinations which belong to the idea of motion and velocity (from which, mainly, Newton took the name of *fluxions*) because in them the thought does not appear in its proper abstraction but as concrete and mixed with non-essential forms." Within the Hegelian scheme of things these more concrete or complex mathematical determinations have their proper context not within pure logic but within a systematic exposition of the science of mechanics (*Encyclopaedia* Sect. 259).

Most of the purely *mathematical* papers delivered at the conference were concerned in one way or another with the issues raised by this Newtonian conception of mathematics and Hegel's assessment of it. They fell into three main groups: those concerned with the merits of the geometry of the ancients as compared with those of the calculus; those which dealt with the problems surrounding the concept of infinitesimals; and those which explored the implications of the distinction between pure and applied mathematics.

Adrian Moore (St. Hugh's College, Oxford) in "The Method of Exhaustion as a Model for the Calculus," presented a general survey of the method of exhaustion as established by Eudoxus and developed by Archimedes. He contrasted its rigour with the unsatisfactory nature of many of the early applications of the calculus, and by concentrating upon the problem of finding the slope of a tangent to a curve at a particular point he showed why Newton advocated a return to the method of the ancients. In the latter part of his paper he brought out Hegel's awareness of the significance of the issues involved and presented his treatment of the subject as in many respects an anticipation of the work of Cauchy and Weierstrass. Antonio Moretto (Padua), in "Hegel on Greek Mathematics and the Calculus," drew attention to the fact that Hegel was aware of the affinity between the work of Archimedes and that of Lagrange, and explained precisely why Hegel regarded it as possible for the infinitesimal calculus to attain the rigour of the geometry of the ancients.

Niccolò Guicciardini (Milan), in "Newton and the British Newtonians on the Foundations of the Calculus," pointed out that although Newton began by making use of the concept of an infinitesimal quantity, he abandoned it about 1670 for the kinematical concepts of fluxion and moment, and in the *Principia* made use of the method of limits in order to justify infinitesimal techniques. He went on to show that the early Newtonians failed to grasp Newton's final thoughts on the foundations of the calculus and often defined a fluxion as an "infinitely little" quantity. Imre Toth (Regensburg), in "The Dialectical Structure of Zeno's Arguments," brought out the merits of Hegel's lucid and constructive analysis of the arguments by which the followers of Parmenides attempted to prove the unreality of motion. His central thesis was that the main problem presented by the Paradox of Achilles and the tortoise is whether or not a definite property P, consistent with the definition of and assigned additionally to the recursively enumerable set H can also be assigned to the pre-existent transfinite telos T. He maintained that since there is no way of deciding one way or the other, it is an unsolvable problem, both the positive and the negative answer being consistent with the explicit premise of the argument. The open alternative can only be decided if an additional axiomatic sentence is included among the premises.

Ivor Grattan-Guinness (Middlesex Polytechnic), in "Varieties of Mechanics in the Eighteenth Century," made the point that it would be wrong to think of the mechanical sciences and the associated mathematical techniques of the period as having been exclusively Newtonian. The general science of mechanics had several distinct aspects—molecular, corporeal, celestial, planetary, technological—and within each of them there were various traditions competing with each other in respect of generality of conception and efficacy of use. Louk Fleischhacker (Twente University), in "Mathematics and Mechanics in Hegel's Philosophy of Nature," concentrated upon Hegel's awareness of the gap that then existed between pure mathematics and its applications. He pointed out that the essence of his attempt to overcome it lies in his treatment of quality, quantity, and measure in the *Science of Logic*. This treatment is not only a systematic analysis of the logical or categorial foundations of mathematics, it is also a sophisticated philosophy of science and provides us with a valuable method for assessing experimental work and establishing mathematical connections between measurable quantities.

The papers read at the conference, together with an edited version of the discussions, are due to be published in book form. In many respects, the volume will constitute the sequel to *Hegel und die Naturwissenschaften* (Stuttgart 1987), which also included several papers on the significance of Hegel's philosophy of mathematics.

Report on the Second Austrian Symposium on the History of Mathematics: Mathematics—*à la mode*?

Neuhofen an der Ybbs, Lower Austria, 22 to 28 October 1989

BY CHRISTA BINDER

Institut für Technische Mathematik, Technische Universität Wien, Wiedner, Hauptstr, 8-10, A-1040 Vienna, Austria

The subtitle of the meeting was "Trends and Tendencies in Research, Teaching and Style." The scientific program consisted of 19 lectures, all followed by extensive discussions on topics ranging from special questions raised by the lecture to general remarks on *Mode* in mathematics. We still do not know if there are, or were, *Moden* in the history of mathematics, but we know of some examples of fields which were considered to be *modern* and which did influence the development of mathematics.

In addition to the scientific program, the Symposium included an excursion to the convent of Melk, where the participants had the possibility to visit an exposition on *900 years of Benedictines in Melk* in the wonderfully baroque building and church and a further excursion to Sonntagsberg, a pilgrims' church on a hilltop, also baroque, with a beautiful view over the landscape and a wonderful sunset.

One of the less official highlights of the Symposium was an evening lecture of H. Wussing on science during the French Revolution, illustrated by slides of stamps.

There were 30 participants and three accompanying persons from nine countries. A volume (approximately 120 pages) with short versions of the lectures is available from Christa Binder at the above address.